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ABSTRACT

This study examines the extent to which some students comprehend four integrated science textbooks and the relationships among their grade level, gender, school location and type, and ability to comprehend the texts. Jamaican high school students (N=160) were the subjects of the study which involved data sources such as cloze, comprehension, technical, and nontechnical vocabulary tests. Results indicate that most of the subjects could not comprehend the texts. Urban and traditional school students significantly outscored their rural and nontraditional school counterparts on all the tests while Grade 9 students significantly outscored Grade 8 students on some tests. Girls significantly outscored the boys on two of the comprehension tests and there are significant correlations among the subjects' school location and type and performance on all tests, and grade level and gender and performance on some of the tests. Contains 24 references. (Author)

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Relationships Among Students' Grade Level, Gender, Location and School Type and Abilities to Comprehend Four Integrated Science Textbooks

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Abstract

This study determined the extent to which some students comprehended four integrated science textbooks and the relationships among their grade level, gender, school location and school type and abilities to comprehend the texts. The 160 subjects, who were selected from four mixed Jamaican high schools, comprised 68 eighth graders, 92 ninth graders, 69 boys, 91 girls, 61 rural and 99 urban students, 70 and 90 of whom were from traditional and nontraditional high schools respectively. Cloze, comprehension, technical and nontechnical vocabulary tests, developed by the authors, were used for data collection. The results indicated that most of the subjects could not comprehend the texts; urban and traditional school students significantly outscored their rural and nontraditional school counterparts on all the tests, while the 9th graders significantly outscored the 8th graders on the tests on only some of the texts, the girls significantly outscored the boys on two of the texts' comprehension tests; there were positive, significant correlations among the subjects' (a) school location and school type and performance on all the tests, and (b) grade level and gender and performance on some of the tests.

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Introduction

Science textbooks continue to influence significantly science teaching and learning (e.g. DiGisi & Willett, 1995; Holliday, 1984; Soyibo, 1996, in press). Teachers' and students' heavy reliance on science textbooks appears to be more crucial in the developing countries such as the Caribbean nations where laboratory facilities are inadequate and the lecture method is the dominant teaching strategy (Soyibo, in press).

Many studies have indicated that many students are unable to comprehend many prescribed science textbooks because their readability levels are often above the students' reading ages. Chiang-Soong and Yager (1993) reported that two out of the five science textbooks used by American junior high school students exceeded their readability levels, while Johnson and Johnson (1987) found that about half of the 52 British physics textbooks written for 13-15-year-olds were above their reading ages. Clarke (1984) reported that Jamaican 7th graders experienced difficulty in comprehending five integrated science textbooks written for them.

Many students find many science textbooks difficult to comprehend for several reasons. These include the texts' layout, vocabulary load, concept difficulty and density, writing style, specific content (e.g. the formulae, equations and graphs) and lengths of sentences (Chiang-Soong & Yager, 1993; Johnson & Johnson, 1987; Soyibo & Thorpe, 1995). Farr and Carey (1987) contend that the development of reading vocabulary is the first step in developing students' reading comprehension while Edwards, Scanlon and West (1993) review studies indicating that technical and nontechnical vocabularies present difficulties to students. Other factors that influence students' reading comprehension

include their linguistic competence, prior knowledge of topics and reasoning ability (Schell, 1988). Moreover, in bilingual and bidialectual societies such as Jamaica, students have to transpose concepts from one language to another. According to Glasgow (1981) this need increases students' readability difficulties. For students to learn science well and do well in science examinations, they must be able to read and comprehend their science textbooks and related materials on their own. Yet, the Caribbean Examinations Council's (CXC) Examiners' Reports (1985-1997) reveal that poor reading and writing skills contribute to many high school students' (including Jamaican students') annual poor performance in science examinations.

The readability of a printed material is the extent to which it can be read and understood by its readers (Soyibo, 1996). Readability formulae and graphs are used to determine textbooks' probable reading difficulty levels but they do not assess students' actual comprehension of the texts. Vocabulary, Cloze and comprehension tests are some of the techniques often used to determine whether or not target students can actually comprehend prescribed textbooks (Johnson, 1979). This was one rationale for using the three methods in this present study.

Several studies, which have investigated some independent variables that are linked to students' abilities to comprehend science textbooks have conflicting findings. While Skaalrik and Rankin (1994) found significant differences in boys' and girls' verbal abilities in favor of girls, Soyibo and Thorpe (1995) found no gender differences in their subjects' abilities to comprehend two biology texts. The findings of some studies on the link between differences in school location and students' ability to comprehend science

textbooks that we are aware of favor urban students (Haller, Child & Walberg, 1988; Soyibo & Thorpe, 1995; Yore, 1997). This study is novel and worthwhile because we are not aware of any published studies on the correlations among students' grade level, gender, school location and school type and their abilities to comprehend any integrated science (IS) textbooks. Hence, this study provides new findings on the links among these four independent variables and students' abilities to comprehend the selected IS texts while conflicting with and confirming some previous findings in this area.

Purpose

This study aimed at determining if (a) selected Jamaican students could comprehend four IS textbooks based on the Cloze, comprehension, nontechnical and technical vocabulary tests, and (b) there were any significant differences in their performance linked to their grade level, gender, school location and school type. Answers were sought to the following questions

1. To what extent could Jamaican 8th and 9th graders comprehend selected Cloze passages in four IS texts ?
2. Are there any significant differences in the students' performance on the Cloze, comprehension, technical and nontechnical vocabulary tests on textbooks A-D linked to their grade level, gender, school location, and school type ?
3. Are there any significant relationships among the students' grade level, gender, school location and school type and their performance on the four tests?

Methodology

Sample The main study sample of 160 students, selected in intact classes from four mixed high schools in Jamaica comprised 68 eighth graders, 92 ninth graders, 69 boys, 91 girls, 61 rural and 99 urban students, 70 and 90 of whom were from traditional and nontraditional high schools respectively. The pilot sample of 281 students from nine classes in one mixed traditional high school comprised 158 eighth and 123 ninth graders.

Textbooks The IS textbooks investigated were: (i) Commissiong, F., Dalgety, F., Jackson, C. & Mee, A. J. (1989). Integrated science for Caribbean schools. Book 1. (labeled text A), (ii) Mitchelmore, J. (1989). Exploring science. Book 1. (labeled text B), (iii) Mitchelmore, J. (1990). Exploring science. Book 2. (labeled text C), and (iv) Commissiong, F. et al. (1990). Integrated science for Caribbean schools. Book 2. (labeled text D).

Instrumentation

The descriptions of the four instruments used for data collection now follow.

Cloze tests The Cloze test procedures (Ransom & Synder, 1991) were applied to three passages in each text as follows: from the beginning, middle and towards the end. The caption of each passage was given. The first sentence of every passage was left intact. Starting from the second sentence, every seventh word was deleted. Each deletion was replaced with a blank. The blanks were about of equal length. Exact replacements and synonyms of the deletions were counted as correct in the scoring. The maximum scores for the texts were A 29, B 29, C 18, and D 31. The captions of the texts' passages are as follows: A (Recognizing disease-carrying mosquitoes, Crystals, Climate), B (What is mass

?, Clothes, What happens when there is an earthquake ?), C (Where does the color go ?, Food processing, Sleep), D (Magnets and things they can do, Mineral salts, Seeing).

Comprehension tests Literal and inferential questions were set on three passages in each text. The maximum scores for the texts were: A 16, B 14, C 18 and D 13.

Technical and nontechnical vocabulary tests Students were asked to explain the meanings of six technical and six nontechnical words selected from the beginning, middle and near the end of each text. The maximum score for each of test per text was 12.

Procedure The Cloze, comprehension, technical and nontechnical vocabulary tests were presented as a worksheet on each textbook with specific instructions for the subjects. A panel of two language and two science education experts on language gave the four instruments and scoring schemes face and content validity prior to their pilot-testing in October 1996 and their administration for the main study from December 1996 to January 1997. The subjects spent 40 minutes under examination conditions to respond to each worksheet. Prior to the administration of the instruments for the main study, 1 or 2 sentences were deleted from three Cloze passages used in the pilot study because a significant number of the pilot students failed to respond to them. The Cronbach alpha coefficients of the worksheet ranged from .26 to .75 for the pilot study and .54 to .85 for the main study. Generally, the pilot subjects' performances on the instruments were comparable to those of the main study subjects but slightly lower.

Results and Discussion

The first purpose of this study was to determine the extent to which the students could comprehend selected passages in the four textbooks based on the Cloze tests. According to Melnik and Merritt (1972), there are three main levels of reading comprehension: independent (when a reader or student can read and comprehend a passage unaided), instructional (when a student needs a teacher's guidance to read and comprehend a passage), and frustration (when a student experiences great difficulty in comprehending a passage even with the teacher's help). Melnik and Merritt (1972) indicate that the scores of persons reading a comprehension passage at the three levels are as follows: independent (not less than 90%), instructional (75% and above), and frustration (50% or less). Using a similar categorization, Ransom and Synder (1991) outline the levels of reading Cloze text passages as independent (60% and above), instructional (40-60%) and frustration (below 40%). Using these guidelines, the students' raw scores were converted into percentages and grouped into three reading levels as shown in Table 1.

TABLE 1 HERE

Table 1 data indicate that only about 2-9% of the students comprehended the texts independently, 12-41% of them comprehended the texts at the instructional level, while the majority (55-87%) of them, could not comprehend the texts but read them at the frustration level. It has been suggested that if about two-thirds of a class cannot read and comprehend a textual material at the independent level, then the text is unsuitable for the group (Melnik & Merritt, 1972). This study's data show that about 86% of the subjects

could not comprehend the selected passages suggesting that the four textbooks were unsuitable for them. This study's findings are consistent with those of some previous studies (e.g. Clarke, 1984; Soyibo & Thorpe, 1995).

TABLES 2 - 3 HERE

To confirm if there were significant differences in the students' performance on the Cloze, comprehension, technical and nontechnical vocabulary tests, on books A-D linked to their grade level, gender, school location, and school type, four 4-way analyses of variance were computed on each text. To save space, only the F ratios are shown in Tables 2-5. The results in Table 2 (and further analyses) indicate that while there were significant differences in the students' Cloze test performance on all the texts in favor of urban and traditional high school students, there were no significant gender differences in their performance, while the 9th graders performed significantly better than the 8th graders only on text B. Table 3 data suggest that there were significant differences in the students' comprehension test performance on all the texts in favor of urban and traditional school students, while the significant differences in their performance on texts A and B was in favor of the 9th graders and those on B and C were in favor of girls. Further analyses revealed that the students' mean score on the comprehension test on each text seems to be above "average" because their overall percentage scores were as follows: A 69%, B 72%, C 73% and D 72%.

TABLES 4 & 5 HERE

Table 4 indicates that there were no significant gender differences in the students' technical vocabulary test performance on all the texts but there were significant

differences in their performance on (a) only text D in the 9th graders' favor, (b) all the texts in urban students' favor, and (c) texts A, C and D in favor of the traditional school students. Table 5 data suggest that there were significant differences in the students' nontechnical vocabulary/text performance on (a) only text A in the 9th graders' favor, (b) all the texts in favor of urban and traditional school students, while there were no significant gender differences in their performance. Further analyses showed that most of the students had (a) a low knowledge of the nontechnical vocabularies tested considering their mean and percentage scores on each text as follows: A 4.4(37%), B 5.39(45%), C 5.10(43%), and D 3.70(31%) and (b) better knowledge of the nontechnical vocabularies than the technical ones on which their scores were as follows: A 2.90(24%), B 2.70(23%), C 2.12(18%) and D 3.48(29%).

Noteworthy was the significantly better performance of urban and traditional high school students on virtually all the four tests on each text compared with the other groups of students. Two of the possible reasons for this finding are that, Jamaican urban and traditional high schools usually (a) enrol the more academically able students (who passed the common entrance examinations (CEE)) than the rural and nontraditional high schools (which enrol mainly students who failed the CCE), and (b) enjoy the services of more and experienced university trained graduate teachers than the rural and nontraditional high schools (Soyibo & Collins-Figueroa, 1996). Such teachers are more likely to provide the academic motivation and stimulation that could facilitate the development of their students' reading skills and general better academic performance. This study's findings are supported indirectly by those of Soyibo and Thorpe (1995). The students'

comprehension test performance outlined above seems to be satisfactory. But if one accepts Melnik and Merritt's (1972) suggestion that for a reader to be at the independent level on reading comprehension, he or she must score not less than 90%, then, it could be inferred that none of the subjects sampled in this study comprehended the selected passages. Again, if the students' performance on the Cloze, technical and nontechnical vocabulary tests is considered, it seems implicit that none of the four texts was suitable for them. Although Table 3 data suggest that there were significant gender differences in the students' comprehension test performance on texts B and C in the girls' favor, a close examination of their mean scores revealed that the "real" differences were not "actually" markedly substantial. Hence, the comprehension tests' data should be cautiously interpreted. However, the girls' significantly better performance than the boys' is consistent with the finding of Skaalrik and Rankin (1994). The results also indicate that the students' low comprehension of the texts' technical and nontechnical vocabularies was a critical source of variation in their abilities to comprehend the texts' passages. The finding that the 9th graders significantly outscored the 8th graders on only a few of the tests was unexpected because, based on their age and relatively longer exposure to education in science, they were expected to outscore the latter on all the tests.

To establish if there were any significant relationships among the students' grade level, gender, school location and school type and their performance on the Cloze, comprehension, technical and nontechnical vocabulary tests, Pearson product-moment correlation coefficients were computed. The results are shown in Tables 6-9.

TABLES 6 - 9 HERE

The data in Tables 6-9 suggest that there were weak to moderately strong, positive, statistically significant relationships among the students' school location and school type and performance on the four tests on all the texts ranging from r = .17 (text C) to r = .64 (text A). The relationships were in favor of urban and traditional high school students. The only exception was the weak, positive relationship r = .14) between the students' text B technical vocabulary scores and their school type which was not significant. The data also indicate that there were weak, positive, significant relationship between the students' (a) grade level and their comprehension and nontechnical vocabulary scores on text A (Table 6), their Cloze and comprehension scores on text B (Table 7), technical vocabulary scores on text D (Table 9), (b) gender and their comprehension scores on texts B and C (Tables 7 and 8). These findings further confirm the results in Tables 2-5 discussed earlier. But the low or weak relationships suggest that there were other sources of differences in the students' abilities to comprehend the texts besides the four independent variables examined in this study. These should be identified and investigated in future studies on this topic.

Conclusions and Implications

The Jamaican 8th and 9th graders' low performance on the four tests indicates that most of them could not comprehend the four textbooks which are specifically written for Caribbean 7th and 8th graders. This implies that the texts were unsuitable for most of the subjects. Hence, we suspect that the texts are likely to be unsuitable for many other 7th and 8th graders for whom the texts are actually written. That 86% of the

subjects were reading the textbooks at the frustration level implies that they and the 7th and 8th graders for whom the texts are written need regular explicit instruction on science reading strategies and actual reading sessions during their science lessons if they are to meaningfully learn the textbooks' science content

The low performance of the subjects on all the tests implies that, all the subjects, irrespective of their grade level, gender, school location and school type, need their science teachers' assistance during lessons to comprehend the four textbooks. Unless the ilks of the subjects sampled are assisted by their science teachers so they can comprehend the texts, they are not likely to learn science meaningfully and do well in the subject. This is because reading in science is more difficult than reading done in organized classes and because students for whom English is a second language have extremely limited language skills to make use of written texts (Zintz, 1975). Unfortunately, Soyibo (in press) reports that the lecture-demonstration teaching mode predominates in most Jamaican grades 7-9 integrated science lessons.

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Table 1 Students' Cloze Tests Reading Levels in Percentages

	Text A		Text B		Text C		Text D	
Reading Level	*Gra 8	Gra 9	Gra 8	Gra 9	Gra 8	Gra 9	Gra 8	Gra 9
Independent	2	8	0	2	1	5	11	9
Instructional	26	37	35	41	12	30	16	27
Frustration	72	55	65	57	87	65	84	64

*Gra = grade level

Table 2 Summaries of ANOVA on Students' Cloze Scores By Grade Level, Gender, Location and School Type

Source of Variation	Book A F	Book B F	Book C F	Book D F
Grade Level	1.48	12.82**	2.11	0.93
Gender	0.61	0.23	0.07	0.11
School Location	33.94**	89.76**	41.35**	31.77**
School Type	77.28**	42.10**	35.37**	30.00**

*p < .05 **p < .001

Table 3 Summaries of ANOVA on Students' Comprehension Scores By Grade Level, Gender, Location and School Type

Source of Variation	Book A F	Book B F	Book C F	Book D F
Grade Level	4.48*	9.95*	1.15	2.91
Gender	0.00	9.89*	6.11*	0.00
School Location	52.10**	47.45**	28.00**	31.65**
School Type	64.04**	38.95**	20.25**	32.90**

*p < .05 **p < .001

Table 4 Summaries of ANOVA on Students' Technical Vocabulary Scores By Grade Level, Gender, Location and School Type

Source of Variation	Book A F	Book B F	Book C F	Book D F
Grade Level	0.69	0.32	0.92	9.58*
Gender	1.41	0.41	2.34	1.17
School Location	60.55***	14.58***	16.97**	32.53***
School Type	9.75**	3.16	4.55*	29.25***

*p < .05 **p < .01 ***p < .001

Table 5 Summaries of ANOVA on Students' Nontechnical Vocabulary Scores By Grade Level, Gender, Location and School Type

Source of Variation	Book A F	Book B F	Book C F	Book D F
Grade Level	10.43*	0.01	0.46	1.83
Gender	1.07	1.31	0.60	0.11
School Location	54.70**	20.90**	43.65**	19.99**
School Type	34.87**	15.79**	22.50**	20.84**

$p < .05$ **$p < .001$

Table 6 Correlations Among Students' Grade Level, Gender, School Location and School Type and Scores on Book A

	Categories of Tests			
Independent Variables	Cloze	Comprehension	Technical Vocabulary	Nontechnical Vocabulary
Grade level	0.12	0.21*	0.16	0.23*
Gender	0.01	0.04	0.44	0.05
School Location	0.53*	0.58*	0.64*	0.57*
School type	0.51*	0.47*	0.21*	0.34*

*$p < .01$

Table 7 Correlations Among Students' Grade Level, Gender, School Location and School Type and Scores on Book B

	Categories of Tests			
Independent Variables	Cloze	Comprehension	Technical Vocabulary	Nontechnical Vocabulary
Grade level	0.25**	0.21**	0.15	0.13
Gender	0.02	0.18*	0.06	0.05
School Location	0.62**	0.52**	0.37**	0.47**
School type	0.41**	0.32**	0.14	0.29**

*p < .05 **p < .01

Table 8 Correlations Among Students' Grade Level, Gender, School Location and School Type and Scores on Book C

	Categories of Tests			
Independent Variables	Cloze	Comprehension	Technical Vocabulary	Nontechnical Vocabulary
Grade level	0.12	0.14	0.11	0.13
Gender	0.01	0.17*	0.13	0.04
Location	0.64**	0.51**	0.43**	0.59**
School type	0.37**	0.23**	0.17*	0.29**

*p < .05 **p < .01

Table 9 Correlations Among Students' Grade Level, School Location and School Type and Scores on Book D

Independent Variables	Categories of Tests Cloze	Comprehension	Technical Vocabulary	Nontechnical Vocabulary
Grade level	0.14	0.12	0.17*	0.15
Gender	0.02	0.06	0.06	0.07
School Location	0.52**	0.48**	0.46**	0.42**
School type	0.38**	0.42**	0.34**	0.36**

*p < .05 **p < .01